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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/015,433	12/12/2001	Martin Kranz	5318/CALB/COPPER/PJS	5742

32588 7590 11/10/2003

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EXAMINER	
TRAN, BINH X	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 11/10/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/015,433	KRANZ ET AL.
	Examiner	Art Unit
	Binh X Tran	1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 August 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-32* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *18* is/are allowed.

6)☒ Claim(s) *1-17 and 19-32* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claims Interpretation

1. In claims 1 and 10, the applicants wrote, "The method for...., the method comprising... a pre-clean process comprising forming a plasma from a gas mixture consisting of..." (emphasis added). As the applicants aware, the MPEP defines that the term "comprising", is inclusive or open-ended and does not exclude additional, unrecited elements or method steps, whether the term "consisting of" excludes any element, step, or ingredient not specified in the claim. According to MPEP 2111.03, when the phrase "consists of" appears in a clause of the body of a claim, rather than immediately following the preamble, it limits only the element set forth in that clause; other elements are not excluded from the claim as a whole. Therefore the examiner certainly reserves the right to interpret any additional gas used in the in the prior arts process belong to "other elements are not excluded from the claim as a whole" (i.e., any additional gas in the prior arts can be interpreted as another plasma mixture).

2. The examiner also considers any cleaning or etching process having the same cleaning or etchant composition with the applicants' composition will read on the term "pre-cleaning".

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –

> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

4. The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

5. Claims 1-3, 5 and 32 are rejected under 35 U.S.C. 102(e) as being anticipated by Hills et al. (US 6,217,786).

Hill discloses a cleaning/etching process on the substrate comprising the step of:

disposing the substrate on the substrate support member (514) in the process chamber;

cooling the substrate to a temperature of –20 °C to 40 °C (col. 4 or col. 6);

exposing the substrate to a cleaning/etching process comprising a plasma from the gas mixture consisting of non-reactive gas argon and reactive fluorine containing gas (i.e. C4F8) (Table in col. 6).

Respect to claim 2, Hills discloses the step of electrostatically chucking the substrate to the support member (col. 4 lines 9-12). Respect to claim 3, Hills discloses flow a gas through the substrate support member to an area between the substrate support member and the substrate (col. 4 lines 16-29). Respect to claim 5, Hills discloses transferring heat from the substrate through the substrate support member to

helium cooling gas (col. 4 lines 16-29, read on "heat transfer fluid"). Respect to claim 32, Hills discloses the non-reactive gas is argon or nitrogen (Table 2 in col. 6).

6. Claims 10-12, 16 are rejected under 35 U.S.C. 102(e) as being anticipated by Chou et al. (US 6,337,277).

Chou discloses a method comprising:

disposing the substrate (24) on a substrate support member in a process chamber (col. 8 lines 26-45);

electrostatically chucking the substrate to the substrate support member (col. 7 lines 45-49);

cooling the substrate to less than –10 °C (read on "cooling the substrate to a temperature less than about 100 degrees Celsius"; col. 8 lines 46-50, Fig 2 step 54);

exposing the substrate to a pre-clean process consisting of a non-reactive gas (col. 9 lines 42-43).

Respect to claim 11, Chou discloses the top electrode is inductive electrode using RF power of 400 Watts to 800 Watts (col. 5 lines 50-53 and col. 13 lines 3-6; within applicants' range of 1-1000 Watts). Chou further discloses the biasing the substrate support with a power of 50-200 Watts and a pressure of 6-20 mTorr (read on "less than about 300 Watts" and "0.5-100 mTorr" col. 13 lines 1-6).

Respect to claim 12, Chou discloses transferring the substrate to the substrate support member disposed in a process chamber (Fig 2). Respect to claim 16, Chou discloses the plasma comprises argon, nitrogen or helium (col. 9 lines 40-42).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hills in view of Maxwell et al. (US 5,996,353).

Hills fails to disclose transferring heat from the substrate through the thermoelectric device. However, Hills clearly discloses the step of transferring heat from the substrate. Maxwell discloses the use of thermoelectric device for transferring heat. It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Hills in view of Maxwell by using the thermoelectric device because it will help this allow a high control of temperature.

9. Claims 7-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hills in view of Subrahmanyan et al. (US 6,107,192).

Respect to claim 7, Hills fails to disclose the step of etching native copper oxide from the substrate. Subrahmanyan discloses the step of etching native copper oxide from the exposed layer (col. 6 line 59 to col. 7 line 24). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Hills in view of Subrahmanyan by etching the native copper oxide from the exposed layer because it will remove contaminants prior to metallization. Respect to claim 8, Hills teaches to biasing the substrate support (lower electrode) with the power 0-2500 watts (Table 1,

overlap the applicant's range of "less than 300 Watts"). Subrahmanyan teaches to apply the power of 300-400 Watts to the inductive coil (col. 9 lines 55-60).

Respect to claim 9, Subrahmanyan discloses flow a reactive gas (i.e. O_2, CF_4 or NF_3) into chamber to reduce native oxides. It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Hills in view of Subrahmanyan by flowing the reactive to reduce native oxide gas because it will remove contaminants prior to metallization.

10. Claims 13-15, 17, 22-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chou in view of Subrahmanyan et al. (US 6,107,192).

Respect to claim 13, Chou fails to disclose cooling the substrate in a degas chamber. However, Chou clearly discloses the step of cooling the substrate in a chamber. Subrahmanyan discloses the step of cooling the substrate in a degas chamber (170) (col. 10 lines 48-52). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyan by cooling the substrate in the degas chamber because it will help to remove gas contaminants.

Respect to claim 14, Chou fails to disclose cooling the substrate in a cool down chamber. Subrahmanyan discloses the step of cooling the substrate in the cool down chamber (176) (col. 10 lines 31-45). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyan by cooling the substrate in the cool down chamber because this allow the substrate be process or cooled in any number of times.

Respect to claims 15, 17, Chou fails to disclose the step of flowing a reactive gas into the chamber to reduce native oxide. Subrahmanyan discloses flowing a reactive gas into the chamber to reduce native oxide (col. 7 lines 48-55). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Subrahmanyan by flowing reactive gas into the chamber to reduce native oxide because it provide an oxygen free interface between the feature and the sub-layer which reduces the resistance of the features.

The limitation of claim 22 regarding two chambers has been discussed above (i.e., degas chamber or cool-down chamber). Respect to claim 23, Chou discloses providing backside gas between the substrate and a substrate support (col. 7 lines 55-61). The limitation of claim 24 has been discussed above. Respect to claims 25-26, Subrahmanyan discloses the step of transferring the substrate to the third processing chamber (175) and depositing a barrier layer of titanium nitride on the at least exposed layer (col. 10 lines 50-60). Respect to claim 27 both Chou and Subrahmanyan disclose the pre-clean process comprise non-reactive gas such as argon or He. The limitation of claim 28 has been discussed above in Chou's reference.

Respect to claim 29, Subrahmanyan discloses the plasma etch remove contaminant without redeposition of metal on the surface or without sputtering of the base of the via (read on "without causing copper agglomerations on via surface", col. 6 lines 59-67 and col. 8 lines 32-39). Respect to claim 30, both Chou and Subrahmanyan disclose the pre-clean process include reactive gas. Respect to claim 31,

Subrahmanyan discloses the step of depositing a barrier layer on the partially exposed and pre-clean the copper feature.

11. Claims 19-20, 27-28, 30-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chou and Denning et al. of each other (US 6,451,181).

Respect to claim 19, Denning discloses process comprising the step of:

disposing the substrate (22) on a substrate support member in a process chamber (10) (col. 13 lines 29-35);

exposing an at least partially exposed copper layer (202a) on the substrate to a pre-clean process (col. 13 lines 48-67);

depositing a barrier layer on the at least partially exposed copper layer (step 412, Fig 12).

Denning fails to disclose the step of cooling the substrate to a temperature of at least 100 °C. Chou discloses the step of cooling the substrate between –20°C to 40 °C (read on "cooling the substrate to a temperature of100 °C or less". It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Denning in view of Chou by cooling the substrate to the temperature below 100 °C because this would protect the sidewall during cleaning. Respect to claim 20, Denning discloses the step of depositing a barrier layer of tantalum nitride (col. 15 lines 45-51.

Respect to claim 27, Chou discloses the method comprising the steps of:

deposing the substrate on a substrate support member within a process chamber maintained at a chamber pressure of 6-20 mTorr (within applicants range, col. 12 line 67 to col. 13 line 2);

cooling the substrate between –20 °C to -40° C by maintaining a gas between a surface of the substrate support and a facing surface of the substrate to transfer heat from the substrate to the support member (col. 7 lines 55-60 and col. 8 lines 46-55);

performing a pre-clean process comprising a plasma comprising non-reactive gas (i.e., argon, He).

Chou fails to disclose exposing the partially exposed copper feature to a pre-clean process gas. Denning discloses the step of exposing the partially exposed copper feature to the pre-clean process gas. It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Chou in view of Denning by exposing the partially exposed copper to the pre-cleaning process gas because it will help to remove contaminant while minimize the copper removal from the surface.

The limitations of claims 28, 30 have been discussed above. Respect to claim 31, Denning discloses the step of depositing a barrier layer (step 412 Fig 12) and pre-cleaned copper feature (step 408 Fig 12).

12. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chou and Denning as applied to claim 20 above, and further in view of Subrahmanyan et al.

Chou and Denning fails to disclose exposing the copper layer to a plasma of a reactive gas selected from the group consisting of fluorine containing gas and hydrogen. However, Denning clearly teaches exposing the copper layer to a plasma gas. Subrahmanyan teaches exposing the copper layer to a plasma of a reactive gas selected from the group consisting of fluorine containing gas and hydrogen (col. 8 lines 40-54). It would have been obvious to one having ordinary skill in the art, at the time of

invention, to modify Chou and Denning in view of Subrahmanyan by using the above gas because it would reduce native oxides.

Allowable Subject Matter

13. Claim 18 is allowed.

14. The following is a statement of reasons for the indication of allowable subject matter: The cited prior arts fail to disclose or suggest the step of exposing an at least exposing copper layer on the substrate to a pre-clean process while maintaining a substrate temperature of less than about 100 degree Celsius on conjunction with depositing a bulk layer of copper on the at least partially exposed copper layer.

Response to Arguments

15. Applicant's arguments with respect to claims 1-5, 7-9 have been considered but are moot in view of the new ground(s) of rejection.

16. Applicant's arguments filed 8-14-2003 with respect to all other claims have been fully considered but they are not persuasive.

Respect to claims 10-11, the applicants argue that "Chou, et al. only describes etching a substrate with a plasma of oxygen and optimally, nitrogen, argon and helium". According to the applicants Chou does not teaches exposing to a "pre-cleaning process comprising a plasma formed a gas mixture consisting of non-reactive gas". The examiner disagrees. As discussed above in the claim interpretation section, the examiner certainly can interpret that the Chou's nitrogen, argon or helium gas the first plasma consisting of non-reactive gas. Any additionally gas such as oxygen can be interpreted as the "second plasma".

Respect to claim 11, the applicants argue that Chou fail to disclose the step of "transferring the cooled substrate". The examiner disagrees. Chou clearly discloses the step of transferring the substrate (Fig 2). The examiner does not need to provide the step of claim 12 in a particular chronological order since applicants does not disclose the particular chronological order.

Respect to claims 12-13, the applicants argue that Subrahmanyan "does not describe or suggest cooling the substrate to less than 100 ° C in the degas chamber". The examiner clearly recognizes that Subrahmanyan fail to disclose the specific temperature. However, Chou clearly discloses cooling to a temperature below 100 °C. The examiner still maintains that the above claim is rejected over Chou in view of Subrahmanyan.

In response to applicant's argument that there is no suggestion to combine the references (i.e. Chou and Subrahmanyan), the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, Subrahmanyan clearly discloses the advantage of reducing native oxides using inert gas composition (col. 7 lines 48-55).

The applicants argue that Denning does not suggest or motivate that cooling the substrate below 100 °c during cleaning would protect the sidewalls of the substrate

during cleaning. The examiner disagrees with this argument. The examiner did not stated that Denning suggest the motivation for cooling the substrate below 100 °C in previous office action. Chou discloses the motivation for cooling the substrate.

Conclusion

17. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Binh X Tran whose telephone number is (703) 308-1867. The examiner can normally be reached on Monday-Thursday and every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G Norton can be reached on (703) 305-2667. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

Binh X. Tran

SUPERVISORY NADINE G. NORTON
PRIMARY EXAMINER